

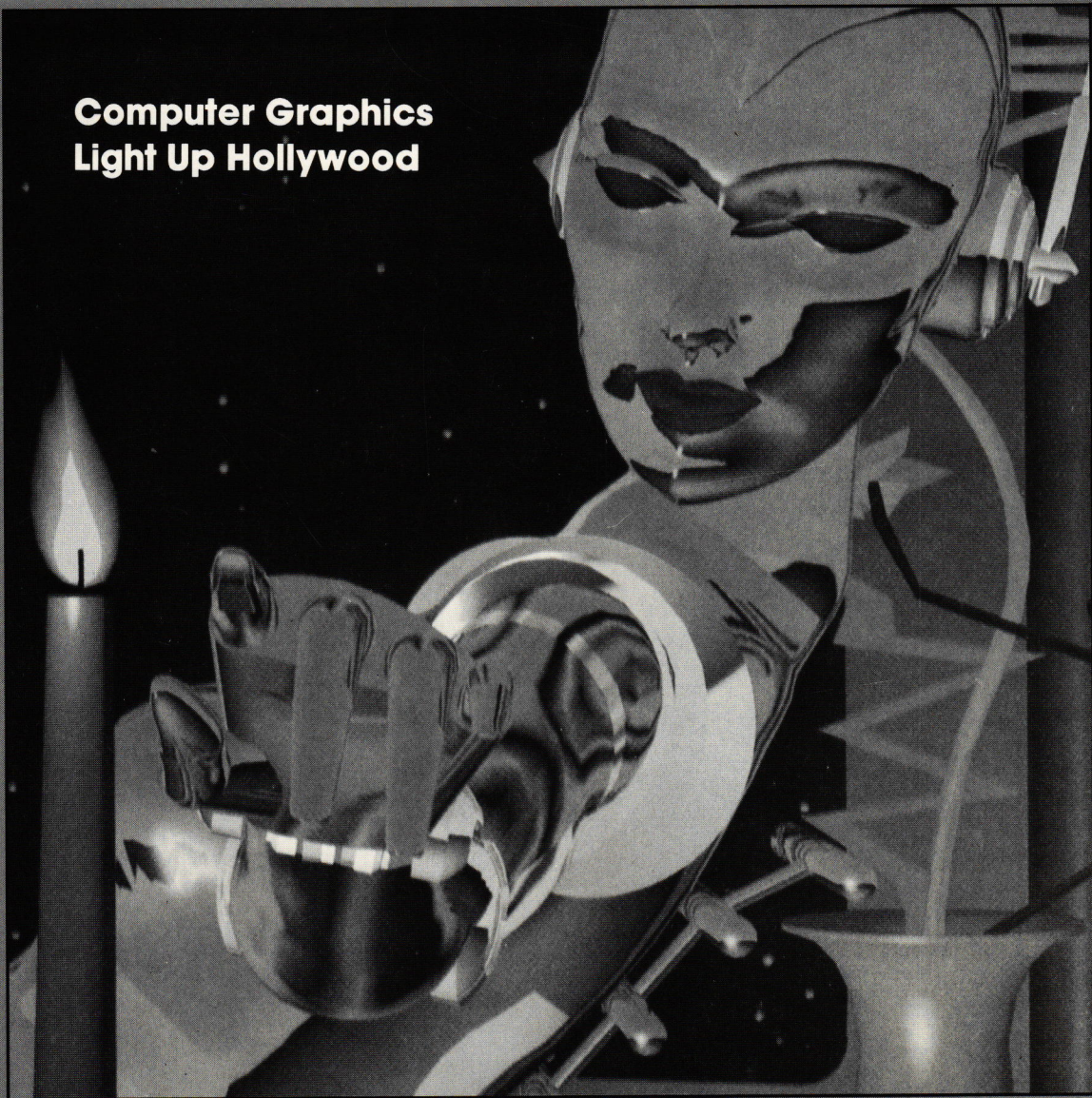
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EDITION 1, SPRING 1986

MECHBOLIV

**Computer Graphics
Light Up Hollywood**



PUBLISHED BY THE ENGINEERS' COUNCIL IN COOPERATION WITH THE ENGINEER ALUMNI ASSOCIATION

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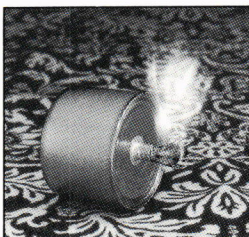
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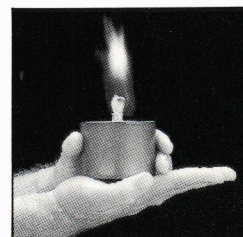
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Special Issue: Recent Trends in Computer Science

Art at the Push of a Button: Computer Graphics Excite and Entertain

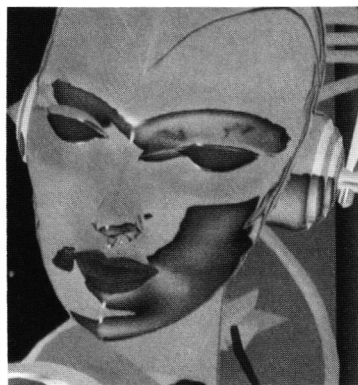
by Lilimar Avelino and
Rose Province

Skeptics of computer technology might argue that the arts are in danger of losing their human touch. Yet graphics designers are convinced that the arts are instead gaining a useful tool, one that will help them achieve new standards of excellence. **4**

Is Your Office a "Tower of Babel?": Improve Communication with Local Area Networks

by April Stokes

"Computer compatibility" used to be an evil phrase in most offices. Now, local area networks allow office workers to share information and peripheral devices, thus speeding up work and improving efficiency. **7**



COVER: Any kind of futuristic vision is possible with the help of computer graphics. Three-dimensional images can be animated to move in fluid motion, with brilliant light and color. Photo courtesy of Robert Abel & Associates.

Artificial Intelligence: Will "Thinking" Computers Be Our Friends or Rivals?

by Zamir Iqbal

A rational, non-human intelligence would be the epitome of the computer scientist's creative work. But can we control a force such as this? Or can we make it work for us? **11**

Expert Systems Point to Possibility of Automated Design

by Stephen A. Osella

CAD/CAM apparatus have already done wonders for the design and drafting fields. Adding the intelligence of expert systems could give computers the power to assist

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by Daniel L. Briller

For nearly a hundred years, the vinyl record was the only means available for storing recorded sound. Lately, though, the digital compact disc has proved itself to be a remarkable replacement, not only for records, but possibly for computer floppy diskettes, as well. **15**

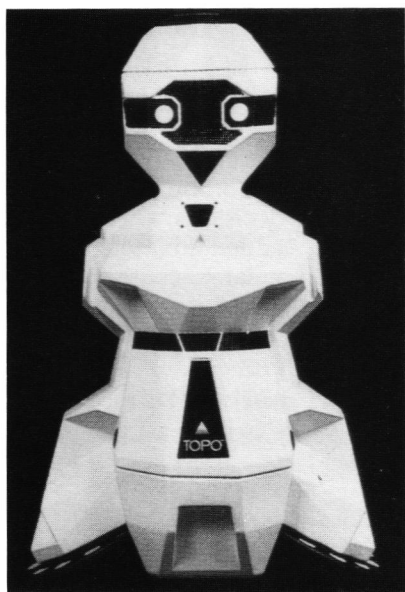
From Cardpunch to CAD/CAM: Computers Invade the Classroom at GWU

by Jeff Winbourne

An now-antiquated "cardpuncher" was once the only piece of computer equipment in SEAS. With the arrival of a new mainframe, CAD/CAM installation, and many other state-of-the-art devices, SEAS is definitely on the frontier of computer technology. **19**

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"Pre-written software instructs the Topo personal robot to give a brief demonstration of its singing and dancing abilities." Courtesy of High Technology.

Robot Progress Hindered by Software

THEY ARE funny, intelligent, loyal, creative and may even save the day. What are they? They are the robots of movies and television. But, unfortunately, reality has to bow its head to science fiction. Though they have greatly improved since they first started, personal robots still lack a great deal. For instance, although the personal robot has the hardware to process images viewed by its video camera, it still does not understand what it sees. Overwhelmingly, the problem lies in software.

A typical personal robot comes with only enough software to run its motors and take readings from its sensors. Most other things have to be programmed by the user, because no application software is available. For example, there is no pre-written software to tell the robot how to wipe a table, or how to vacuum the rug. This would have to be programmed in by the user.

One of the robots on the market is the Topo personal robot (\$1595) made by Androbot. The pre-written software instructs the Topo robot to give a brief demonstration of its singing and dancing abilities. Even though it doesn't come with much software, the robot is compatible with the Apple II and IIe personal computer, and can be programmed from their keyboards. The robot's movement and the pitch of its voice can be adjusted with a personal computer.

Another robot on the market is the RB5X (\$2295). The robot comes with pre-programmed read-only memory chips, which can be inserted directly to the back panel on the robot. Various chips instruct the computer to dance, sing, play games and even act as a security guard.

The Hero Jr. (\$1000) by Heath is more of a product for the general consumer than the two personal robots described above. It comes with much more pre-programmed software, most of which is accessible by pushing a button on the robot's keypad. The keypad contains the programs: Help, Demo, Speak, Sing, Poet, Gab, Play, Guard, Alarm, Setup, and Plan.

Most of the programs listed are self-explanatory, such as Sing, Poet, Play, and Guard. The Alarm program is simply an alarm clock. The main problem with the Hero Jr. is that it is very difficult to program. It is meant only to be used with the software it comes with. In order to program it, the robot must be downloaded with a machine-code file from a personal computer.

Although there have been many advances in robotics, the robot still is not very user-oriented. Most of them require the owner to have a working knowledge of programming. Others come with only a limited amount of software that cannot be extended very easily. Therefore, robots as companions or servants remains a thing of the future.

—Vaiji Ramaswami

Computers Help Spot Spoiled Food

ARE computers, like our parents, watching what we eat? A challenging and productive new technology is already on its way to the factories. Machine Vision, as it is known, is already making waves in the automotive, electronic, and, particularly, the agricultural industries.

Machine Vision systems combine television cameras with computers to identify patterns in detail. Inspection of manufactured items is the most used technical skill of Machine Vision systems. Its computer often makes a simple accept-or-reject decision by comparing the part on the production line against a standard-part image stored in the computer's memory.

Advances have been made in Machine Vision systems—one being the ability to detect shades of gray rather than simple black and white. Gray-scale perception is a prerequisite for the inspecting of color in objects. Since color is an important indicator of food quality, this advance has improved the machines' prospects for use in food processing.

Another advance useful for agricultural applications is the reduced need for lighting. The older systems of Machine Vision often needed carefully controlled lasers or stroboscopic lamps to highlight areas of interest in parts of inspection, but beneficial improvements in computer signal processing now require the equipment to work under normal lighting, for example, sunlight. Hence, this advancement is especially applicable in fields where crops are grown.

The advantages of Machine Vision seem endless. For example, instead of having the entire crop picked in one pass, as is done now by current machine harvesting, Machine Vision with its built-in vision system could select just the

Continued on page 18

Can We Trust Supercomputers?

"CAN computers be made to have human insight, learning abilities, and creativity? Many artificial intelligence programmers think so. They feel that not only is it possible, but it is just over the 'intellectual horizon.' In order to think like human beings, the computer must have the identical processing speed and ability of the human brain. This is where supercomputers come in. The supercomputers designed and produced by Seymour Cray have a processing speed identical to the human mind—two billion calculations per second. With the proper programming, these supercomputers can increase engine combustion, simulate black holes, and propose hypotheses on the origin of the universe.

This Cray supercomputer is necessary to operate the Strategic Defense Initiative (SDI) or Star Wars. The Cray-2, the fastest and most advanced supercomputer, has already been installed at NASA's Ames Research Center. The Cray-2 is the first building block of NASA's plan for a supersystem that would be used in aircraft design, flight research, chemistry, weather prediction, and genetic engineering.

Although it seems that supercomputers are a tremendous advantage for our nation's defense, many among the academic community approach the idea of supercomputers running SDI, and many of NASA's projects, cautiously. They fear that the dream of Artificial Intelligence may go too far, that computers may become too intelligent for their human masters, or that the software of the supercomputers may develop bugs and run amok.

●
Zellman Warhaft, Professor of Mechanical and Aerospace

Engineering at Cornell University, cites the aborted shuttle takeoffs, due to computer error, as an example of the fallibility of computers. Since the programs for the supercomputers running SDI would be even more complicated than the software required for the shuttle, it would leave a larger margin for errors to occur. Warhaft feels that "knowing what computers do and how they act, it would be suicidal to assume that they could be used to operate our defenses."

Yoshio Akama, computer scientist at Tokyo University, thinks the threat of a runaway computer "is very real, but it is not something we cannot defend against." He states that Japanese supercomputers are all designed with a fail-safe system. The Japanese supercomputer is a

parallel computer, which functions by allowing many small computers work on parts of a problem at the same time and dumping their answers into a central processor. A secondary system constantly monitors the flow of information from computer to computer and if any computer sends out information it is not supposed to send out, the secondary system shuts down the main system. It then searches the system for the problem, corrects it, and resets the entire system.

With such fail-safe systems as those protecting Japan's supercomputers, Akama says, "We have created the computer mind. We are the gods over these intelligences. We have the power to make them greater. We have the power to bring them to a halt."

—Vaiji Ramaswami



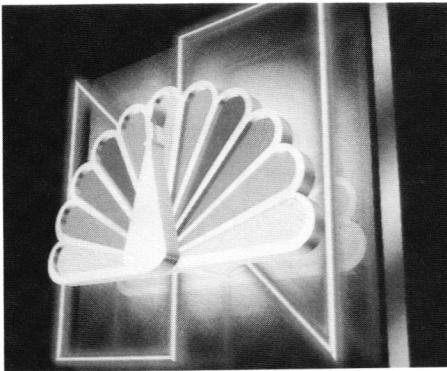
"The Cray Supercomputer has a processing speed identical to the human brain—two billion calculations per second." Courtesy of Popular Mechanics.

ART AT THE PUSH

Computer Graphics

by Lilimar Avelino & Rose Province

QUESTION: What do an Apple MacIntosh and a Cray Supercomputer have in common? Answer: They are both being used in the exciting new field of **computer graphics** and **computer-generated imagery**.



Lights! Camera! Action! The film rolls in a shining display of lights, lasers, and 3-D effects in this eye-catching NBC movie opener. Courtesy of Computer Pictures.

This is the branch of the entertainment industry responsible for providing us with science fiction special effects at the movies and Flintstones animations on TV. In Hollywood, and in hundreds of smaller studios around the country, artists and designers are reshaping the entertainment industry—ironically, with the same computers most often used by research scientists.

One might ask, "Why the big growth in computer graphics?" In this technologically-run society, are even the arts losing their human touch? Many artists, in

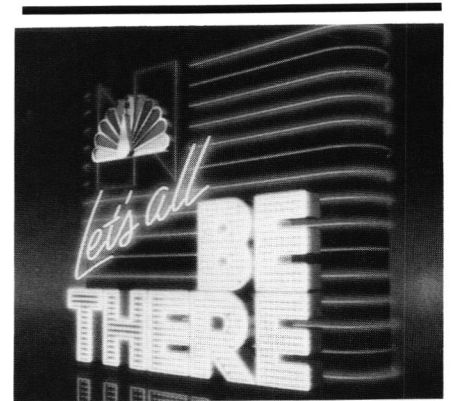
fact, believe the opposite—namely, the arts are gaining a very useful tool with which artists can realize their full potential. The advantages of CGI are indeed numerous. For one, it gives the artist the ability to experiment quickly with various graphic ideas, and store them in computer memory, where they can be retrieved at the touch of a button. It also gives him/her the ability to select from a wide range of colors, and the ability to rotate designs and photographic images so they can be viewed from many angles. There is also no limit to the depth of the field, or the size and position on the object. Ray tracing, shadows, and reflections, are some more techniques that help create dramatic effects and can be done with the aid of a computer.

THE ARTISTIC production of these computer-generated images (CGI) originates at the design studio. The designers, animators, and producers in the design studio must inform, involve, and capture the viewer's interest, with sometimes only five to thirty seconds to operate with. The process of developing an intuitive design requires several steps. Depending on the product, film theme, or show's message, the studio first takes a concept and discusses with the company what can be done to develop that concept. Using 3-D capabilities and a graphic computer, designers start to generate images of that concept. The computer is involved in all phases of the production, which include creating the content, producing the artwork, and distributing the finished product.

MEET THE BIG NAMES (AND SMALL NAMES) IN CGI

In order to lend insight into the development of the CGI industry and give an appreciation for its successes, here are short descriptions of two of the more innovative design studios in the nation and their activities:

●**Digital Effects** owns a Cray X-MP supercomputer, which is used for digital animation. They produced three hundred scenes for the movies "The Last Starfighter" and "2010" with their supercomputer. Among the TV openings they designed are "NBC Nightly News" and the US Golf Tournament. In addition, they designed images for the films "Tron", "AD", and "Vietnam: A Television History." The Cray enables them to capture live action in an exciting way, by utilizing polygon manipulation and metamorphosis to create realistic simulations. Now the studio aims



Reflections, shadows, and streams of brilliant colors and lights, all generated by computer graphics, left viewers of the NBC network opener dazzled. Courtesy of Computer Pictures.

OF A BUTTON: Excite and Entertain



Ya ba da ba doo! Our good ole' friend Fred Flintstone sure looks great with the help of computer animation. Courtesy of Hanna Barbara Productions.

for softer textures, by scanning different possibilities, creating any texture they desire, and moving it in 3-D.

●**California Films** manipulates a Hewlett Packard 9920 for motion graphics, film animation techniques, and 3-D computer graphics. Colors, streaks, high contrast, backlighting, and smooth shaded effects all identify a California Film production. Their HP assists in concept storyboards, film editing, production art, motion/color testing, and detailed animation designs. California films can display a black-and-white motion test on their computer monitor, use video, allow satellite transmission to occur, and ultimately transfer the test to a client for viewing. An example of their work is ABC's

"Sunday Night Movie" logo, done with streaked backlighting.

Just as there are highly innovative design studios that lead the way for the rest of the industry, there are individuals that leave an invaluable mark on the CGI business. One of these individuals is the top designer Henry Marks. The tool by which he generates his computer images is an Apple MacIntosh—these images constitute 95 percent of his graphical productions. His success is due to his ability to work out ideas. When he begins a project, he makes a storyboard, and molds separate concepts into an integrated design. He also keeps track of technological developments by communicating with Pacific Data Images and Digital Communications.

Henry Marks admires top firms like Digital Productions, Cranston/Csuri, and Pacific Data Images for the clear images, fluid motion, and pure colors in their graphics. Yet, he is disturbed by the jerky, annoying, imitative designs of some lower-level studios. Firms with small systems, he believes, "can work within the parameters of their equipment and still do quality work." He is a designer who much prefers "innovative" work to "imitative" work, and he finds that the "innovation" of designers is what provides the "magic" in the creative process of CGI.

Thanks to the design studios, their designers, and their conversion to CGI, this last fall season marked the first time that all major TV networks (ABC, CBS,

and NBC) used computer graphics for their promotional campaigns and in some form of animation. The networks wanted technological designs with brighter colors, motion, and a strong image that could excite and retain their audience.

COMPUTER GRAPHICS MAKE ANIMATION SPARKLE

A major aspect of computer generated images is animation, defined as "any technique for creating an illusion of motion." Yet, this extravagant use of computer-generated images in animation was only a recent development. Before computer graphics, animators used to make a storyboard by hand. For 22 minutes of animation, there would be roughly 15000 drawings.

Xerography, then a big technical breakthrough, made it possible to transfer the drawings to an acetate material directly, without tracing. Even then, a cameraman still would have to photograph the cartoon sequence from frame to frame.

Most of the tedious work involved in producing animation was eliminated by the emergence of computer graphics. The computer enables a designer to



KWANG-YONG QUEK

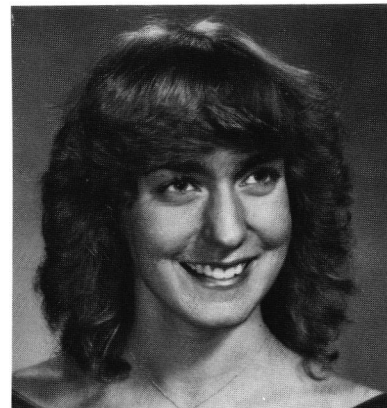
Lilimar Avelino is a sophomore, majoring in Electrical Engineering. She wants to coordinate these studies with a Computer Science minor or a Premedical Engineering major. Lilimar is also TECH BRIEFS Editor of MECHELECIV and works as a co-op student for the Naval Research Lab, in Washington, D.C.

automate those parts of animation that tend to be repetitive. Hanna Barbara's (an animation production company) VAX computer assisted in the writing of dozens of episodes of cartoons, requiring only 22 minutes per episode of work time. Hanna Barbara Productions give the younger generation some elaborately animated classics like, "Tom and Jerry", "The Flintstones", prime-time specials, and other enjoyable cartoons.

THERE ARE several steps involved in making an animation sequence. First, animators' drawings are digitized (converted to a pattern of tiny dots) into the computer, using a video camera and an image-processing frame buffer. Digital Video Effects (DVE) is a prevalent form of graphics animation, by which producers can zoom, spin, tumble, and transform the shape of existing pictures. A paint system used for animation is capable of performing many specialized tasks: it can control animation speed, control color transition routes for a number of frames, allow animation events to occur simultaneously, and allow the operator to always have precise control of the animation.

The coloring work station also makes use of **cel-coloring**, a process where cartoonists can simply point to an area and immediately fill it with color. In the VAX, exposure information describes each frame to directors and animators, and thus the individual pieces are organized with little editing required. Next, the VAX loads the finished frames into frame buffers and records them on videodisk. Finally, sound is dubbed to the finished animation.

With their advanced computer systems, designers, animators, and producers want to learn more new applications of computer-assisted animation. For example, a "multiplane camera" can give the effect of 3-D. More equipment for recording can be used with frame-to-frame assembly. Also, some new effects can be developed to improve painted backgrounds.



COURTESY, ROSE PROVINCE

Rose Province is a Sophomore, majoring in Electrical Engineering, with a Pre-med Option. She has received an Engineering Honors Scholarship and has been on the Dean's Commendation List. Rose currently works for NASA, as a co-op student, at the Goddard Flight Center in Greenbelt, Maryland.

FUTURE DEVELOPMENTS PROMISE MORE "MAGIC"

Future developments in CGI are still necessary. Computers have to become more involved in the preparation of storyboards, in set designing, and in the arrangement of props (keeping track of existing supplies.) Most editing is still manual, but a new videodisk testing technique is being tested.

As more and more supercomputers and special hardware enter the realm of the entertainment industry, their complexity, speed, and high quality will expand the horizons of the CGI industry. There is definitely a strong upward growth trend in the use of computer-generated images including animations for TV shows, films, and commercials. Through the utilization of computer graphics, there exists a considerable potential for almost limitless creativity on the part of designers, animators and producers. In describing the impact of computer-generated images on the entertainment world, Judisen Rosebush of Digital Effects remarks that conventional graphics "are fascinating, but when coupled with the computer's ability to transform objects, the results become magical." ■

IS YOUR OFFICE A "TOWER OF BABEL? : IMPROVE COMMUNICATION WITH LOCAL AREA NETWORKS

by April Stokes

"IMAGINE for a moment you worked in an office where nobody spoke the same

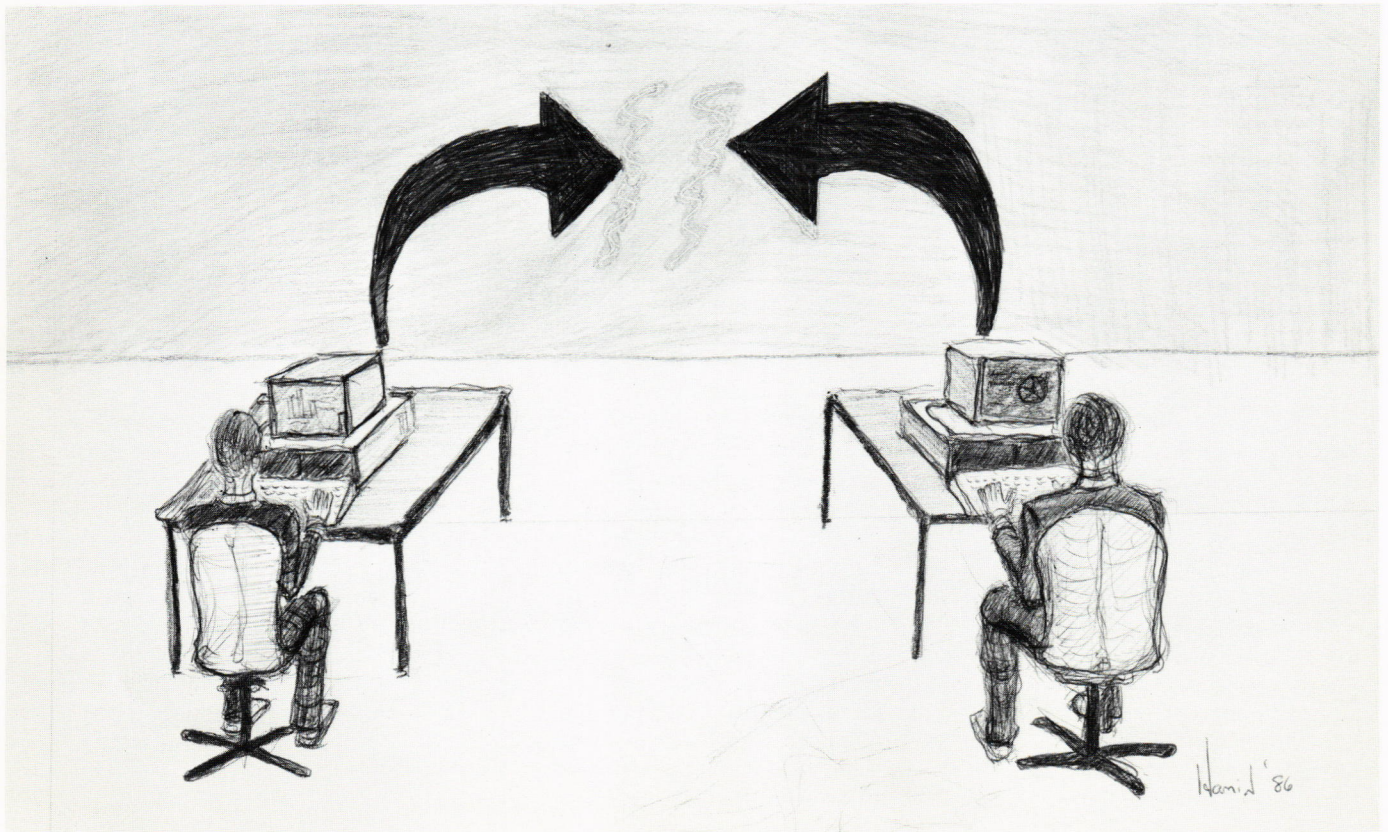
language. Wait now, you say, that sounds next to impossible. Yet, unbelievably, when offices used to buy computers, the computers themselves would very likely be of different models and manufacturers, in no way capable of communicating with each other. The solution to this problem: more compatible computers can now share information when tied together to form **local area networks**.

Since the early 1980's, computer designers and manufacturers have been promoting local area networks (LANs) as the best way to link office personal computers, terminals, and networks. A LAN is a collection of microcomputers and

peripherals linked by a short-range, common communications path. It allows users to share files and provides a cost-effective method for sharing expensive peripherals, such as hard disk drives and laser printers.

LANs AND MULTIUSER SYSTEMS: ARE THEY THE SAME?

There is a small, yet important, distinction between LANs and multiuser systems. A LAN is a system that ties otherwise independent microcomputers together. Multiuser systems use a time-sharing scheme to link terminals. Thus, if a



microcomputer (or workstation if you use mainframe terminology) executes programs with its own memory and its own processor, it is part of a LAN. If the workstation uses only the processor and memory of a central computer, it is part of a multiuser system. When comparing LANs with multiuser systems, LANs are preferred because of their overall flexibility, expandability, and performance.

AN OLD IDEA BECOMES AN OVERNIGHT SUCCESS

LANs are not a new development. The Xerox

Corporation developed Ethernet at its Palo Alto Research Center back in 1976, in order to link several single-user minicomputers. However, the early LANs were expensive and technically complicated to install and maintain. Fortunately, as the concept and systems evolved, LANs became less expensive, yet higher in quality; more flexible, yet easier to install. They also became more sophisticated. Then, LANs attracted the attention of the industry giants.

In fact, 1985 may be considered the year of the LAN. Industry giants IBM and Apple, as well as

newcomer to the industry AT&T, all introduced LANs last year. The smaller companies in the field are now trying to make their systems compatible, especially with the IBM network.

The lack of a true industry standard was the major reason why companies have been reluctant to install LANs. That is, they were until October 15, 1985, the day IBM announced its own local area network. IBM's entry convinced companies that local area networks are more than an experiment. Whether IBM sets a standard and dominates the market remains to be seen, but

Fiber Optics Hits the Cutting Edge of Communications Technology

WILL little glass rods soon replace telephone and computer wiring, underground and in offices? Fiber optics, a technology that was largely experimental up until the late 1970's, is only recently coming into use for applications such as sending digital transmissions through communications networks. Its technical and economic advantages are being established in intercity and metropolitan areas in the U.S. and in other countries where high-traffic communications lines are found. Besides city-to-city connections, the TAT-8 projects, a trans-Atlantic fiber cable currently being laid, will show that high-capacity fiber optics links are more efficient than satellite systems for intercontinental transmission of voice and data signals.

Fiber optics technology is also advancing into other applications, such as Local Area Networks (LAN's). The reason for this "migration" of technology is the rapidly dropping expenses of both initial cost and long-term maintenance of a local system. Additionally, companies that once were able to confine their data transmission requirements to the more conventional means of conduits now need increasing amounts of bandwidth to accommodate high-speed

computers and CAD/CAM applications.

Besides the growing number of applications that are helping proliferate the use of optical fibers are several recent advances in the technology, itself. For example the advent of **single mode** fibers, which can carry signals of optimal wavelength for long distances, makes it possible to transmit at rates of up to 400 Megabits per second (400 million bits per second.) The technology is expected to advance to a point where a network will be able to handle one Gigabit (ten to the power nine bits) per second, within three years. Another important point is that the cable, sources, and detectors used for these transmissions are all decreasing in cost, and becoming more reliable as well.

Major fiber optics networks are currently being installed by the Bell Telephone companies and long-distance carriers such as GTE Sprint, MCI, and AT&T Communications. These projects could result in more than **ten billion** miles of installed fiber optics cable by 1990, mostly in major urban areas such as New York, Boston, Los Angeles, Chicago, and Washington, D.C. Encouraged by the promise of their high speed and long range, telephone companies are now

replacing copper wires with optical fibers in high-density business districts, for example, Wall Street in New York City.

Other possible urban applications include remote, full-service switching centers, for the purpose of consolidating individual users into higher capacity links. This link would then be routed to the main office of a company, such as AT&T or MCI. Yet another possible configuration involves inter-office LANs, or LANs operating within a single building. These could be used for intra-building voice and data communications, between office workers at their PCs and mainframe computers elsewhere.

In coming years, we will see increased usage of fiber optics networks in everyday fixtures of society, such as the control/electrical systems in automobiles. Another application could be in a computerized home of or factory, designed to take advantage of electronic control to keep costs to a minimum. With the combination of less expensive and more reliable VLSI (Very Large Scale Integrated) circuits for control and signal processing and decreasing costs for fiber optics equipment, this industry is poised for rapid growth in the near future.

—Mark L. Abolafia

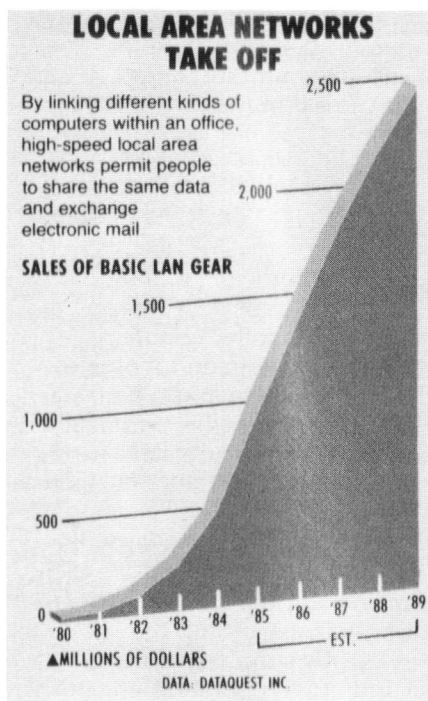
analysts do agree the market will experience tremendous growth. Dataquest predicts a 46 percent compounded annual growth rate for LANs and LAN products through 1988, which translates into roughly 7.1 million networked microcomputers.

HARDWARE COMPONENTS: WHAT YOU NEED, WHAT YOU DON'T

In its simplest form, a LAN is a group of microcomputers or workstations connected by cables. More sophisticated LANs include interconnections with other networks, various peripherals, and a host of specialized components. However, no matter how complicated the LAN, it can be broken up into individual components performing specialized functions.

The term "server" defines a component that handles special tasks within a LAN. It can be either a microcomputer or a peripheral, and it caters to all the requests of the networked microcomputers. A disk server is a hard disk drive that is available to all networked computers. Usually, it is partitioned so that each computer accesses a particular storage area. Some disk servers allow certain storage areas, called public volumes, to be accessed by all workstations. In many cases, access to a particular file is limited to one workstation at a time.

'Since the early 1980's, computer designers and manufacturers have been promoting local area networks as the best way to link office personal computers and terminals.'



Sales of LAN components are expected to reach 2.5 billion dollars worth by 1989. Courtesy of Business Week.

A file server is a more sophisticated version of a disk server. The hardware remains the same, except greater software control over the hard disk drive allows access to data by file name. In more sophisticated LANs, two people at two separate workstations can access a file and update it interactively.

Just about every LAN requires you to insert an expansion board inside your computer, in order to connect it to the network. The board usually contains a microprocessor, a signal converter, and a network interface controller. The major exception to this expansion board is the Macintosh on the AppleTalk network. Cables hook directly into the serial port because Apple has included network circuitry inside the Macintosh.

THE MANY ROADS OF A LAN

In LAN language, the electronic pathways connecting the various components are called **media**. In most cases, the connections are made with twisted-pair wires or coaxial cable, although fiber optics technology is quickly becoming more popular.

Twisted-pair wires consist of two insulated and shielded copper wires wrapped around one another. They are similar to telephone wires and can carry both voice and data. AT&T and Apple both use twisted-pair wiring for their respective StarLAN and AppleTalk LANs. This flexible wire is by far the easiest to install, move, and expand, and it costs much less than coaxial cable and fiber optics. On the negative side, signals traveling through twisted-pair wire lose power with distance unless extended with repeaters (amplifiers that retransmit signals down the line). In addition, twisted-pair wiring is extremely susceptible to electromagnetic interference and radio frequency interference (EMI/RFI).

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"COAXIAL cables are the same as those used by cable TV stations. An outer insulating layer surrounds a metallic sheath. Inside the sheath is an inner insulating layer that encloses a thick central wire. There are three types of coaxial cables used: (1)trunk—a high quality cable used for long stretches, (2)feeder—to come close to the microcomputer, and (3)drop—the smallest and most flexible cable that hooks directly to the microcomputer. Coaxial cable costs more than twisted-pair wiring, and installation is more difficult, due to the relative flexibility of the cable. However, coaxial cables allow signals to travel faster, provide greater resistance to EMI/RFI noise than twisted-pair wiring, and can carry video signals, in addition to data and voice. The IBM PC Network uses coaxial cable.

Fiber optics is a relatively new, yet promising technology for LAN media. Fiber optics changes electrical signals into pulses of light and transmits them along hair-thin lengths of glass. Since fiber optics is a new technology, the industry lacks a broad base of skilled technicians. The cost is much higher than either of the previous two, and they are not



KWANG-YONG QUEK

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easily expandable. On the other hand, fiber optic systems are virtually immune to EMI/RFI and serve best in heavy industrial areas.

CREATING YOUR OWN LAN

The scheme of creating a LAN and linking all the components together is called **topology**. In theory, three main topologies dominate the market: **bus**, **star**, and **ring**. However, in practice, many manufacturers are fusing two topologies together to increase performance.

A bus network consists of a single cable, with taps for each microcomputer and peripheral. As a result, expanding the system is relatively simple, and the LAN will continue to operate if one of the member workstations malfunctions. A bus network is excellent for sending short messages, over small distances.

A star network uses point-to-point paths between a centralized host and the microcomputers and peripherals. All communications funnel through the central host. If the central host malfunctions, the entire LAN shuts down. A star network is good for shared databases, but is not well suited for simple message switching.

A ring network consists of a circle of microcomputers and peripherals. It offers a faster response time than the other two topologies, and it constantly monitors itself. While a ring network offers greater equipment reliability, loss of one station may shut down the entire system. Expanding and servicing this type of network is also difficult.

NETWORKING: IS IT RIGHT FOR EVERYONE?

Whether or not networking is right for a particular company depends on many factors, including the time and money needed to buy and install a LAN. In addition, careful consideration needs to be given to the company's exact needs and future growth

potential. For smaller companies, it may still be more efficient to invest in a multiuser system. Networked microcomputers improve the flow of information, and are taking us one step further into the Information Age. ■

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ARTIFICIAL INTELLIGENCE: *Will "Thinking" Computers Be Our Friends or Rivals?*

by Zamir Iqbal

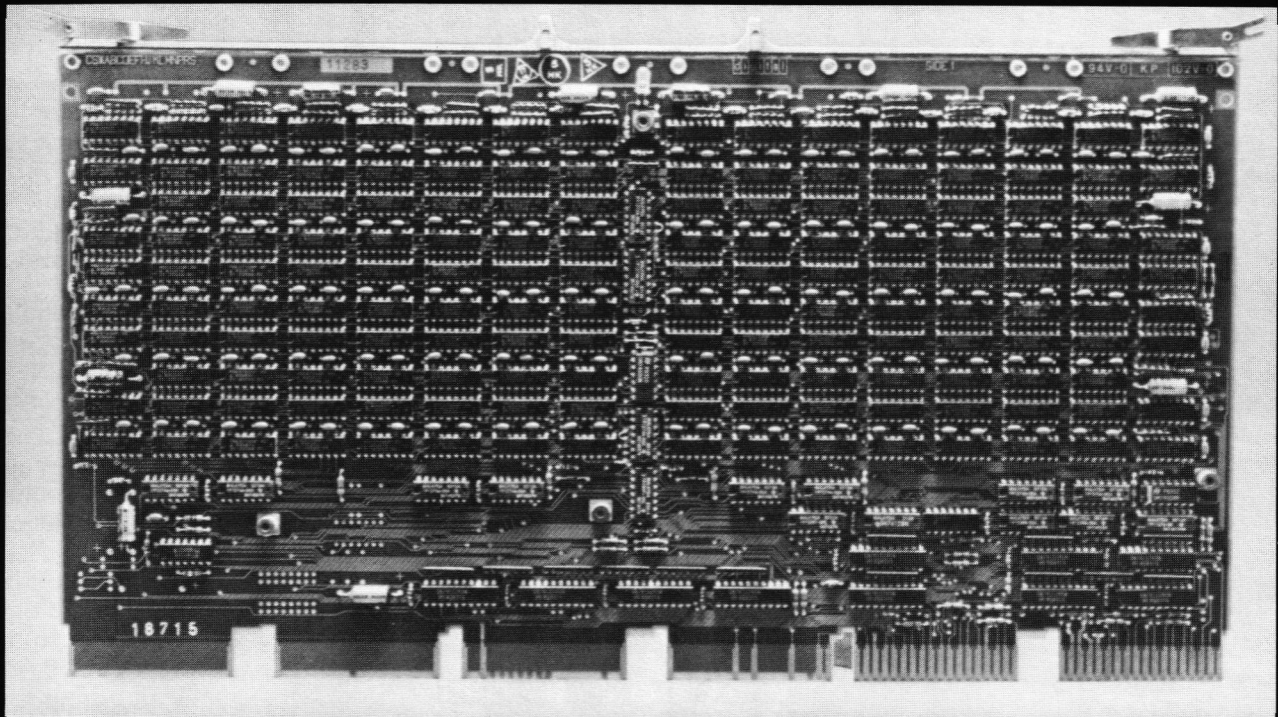
"Daisy, Daisy, give me your answer do . . ." Around 1970, in movie theaters across the world, people sat numbly in their seats, watching an astronaut slowly dismember the "mind" of a most remarkable computer—"HAL". Hal was a computer that could think, talk, and respond in completely human fashion, always able to act in a rational manner, with the least possible influence of emotion. Yet, it had unexplicably gone berserk, deviating from its programmed mission and jeopardizing the lives of the crew . . .

THIS WAS Stanley Kubrick's and Arthur C. Clarke's thrilling, sometimes terrifying, vision of what computers will be like in the year "2001." While a machine like "HAL" may or may not be the ultimate goal of the science of Artificial Intelligence, this often misunderstood and mistrusted discipline has already moved into our lives. The appearance on Earth of a non-human entity with intelligence approaching or exceeding mankind's would rank with the most significant events in history. While we cannot possibly imagine the full consequences, the effects on technology, science, economics, warfare—indeed, on the whole intellectual and sociological development of mankind—would undoubtedly be momentous.

Recent developments in the area of Artificial Intelligence (AI) raise the question of whether researchers are on the threshold of a breakthrough, or are merely resurrecting a bygone fad. But before we go into this issue, it is worthwhile exploring the exact meaning of artificial intelligence, since, even among experts, there has always been disagreement.

WHAT IS "AI?"

There are many ways to define the field of AI. Winston, a founding father of the subject, defines it in very simple words as "the study of ideas that enable computers to be intelligent." But now the question arises, "what is intelligence?" Is it the ability to reason? Is it the ability to acquire and apply knowledge? Is it the ability to perceive and manipulate



The silicon chip is the building block of what may be the first non-human intelligence on Earth. Courtesy of Scientific American.

"Natural Language programs can comprehend and obey orders in everyday English."

things in the physical world? Surely all of these abilities are part of what intelligence is, but, by themselves, they are not the whole of what can be said about it.

"THE definition of AI becomes controversial because the definition of "intelligence" itself appears to be an amalgam of so many qualities, among them, special information processing talents. However, in my personal opinion, Artificial Intelligence can best be defined as the "discipline devoted to equipping computers with intellectual faculties, such as the abilities to perceive, reason, and learn."

The desire to make computers be intelligent is not as the same as wanting to make computers simulate intelligence. Artificial Intelligence excites people who want to uncover the principles that make all intelligent information processors work—whether they are made of wet neural tissues or dry electronics. Consequently, there is neither an obsession with mimicking human intelligence nor a prejudice against using methods that seem to involve human intelligence.

Just as psychological knowledge about human information processing can help make computers intelligent, theories derived purely with computers in mind often suggest possibilities about methods to educate people better. Said another way, the

"One major reason for the fading of AI in its early age was lack of any demonstrated practical use to areas other than games."

methodology involved in intelligently creating programs may help people use their own intelligence more wisely.

THE UPS AND DOWNS OF AI's HISTORY

Ever since the first programmable electronic computers were built, a small and brainy group of researchers in AI has been trying to equip those formidably fast and tireless machines with the ability to "think." In the Fifties, people were intrigued by machines that could beat humans at checkers, prove mathematical theorems, and perform other feats requiring an



"HAL was a computer that could think, talk, and respond in completely human fashion." Courtesy of Popular Mechanics.

even higher level of intelligence in humans. Accompanied by extravagant predictions from the AI community of more practical accomplishments to come, these feats impressed many businessmen. By the end of the decade, many sophisticated companies were actively pursuing machine intelligence.

But only a few practical applications emerged. By the early Sixties, most corporate research efforts had been dissolved. AI researches, among their ranks some of the brightest brains in computer science, continued their obscure investigations at MIT, Carnegie-Mellon, Stanford and a few other universities and think tanks, such as the Rand Corp. and Stanford Research Institute.

Recently though, that old infatuation with AI has resurfaced. Many large, savvy companies like

Digital Equipment, Texas Instruments, Xerox, Schlumberger, Hewlett-Packard, and General Motors are engaged in substantial research efforts. Even IBM, which has for years regarded the notion of a "thinking" computer with fear, is now in the game.

AI SCORE CARD: WHERE IS IT USEFUL?

AI has traditionally attracted gifted computer scientists who were more inclined than most of their colleagues to pursue new ideas, with little thought to their practical application. One major reason for the fading of AI in its

earlier age was lack of any demonstrated practical use to any areas other than games. But, over the years, the field has emerged back on the scene with solid evidence of its progress and achievement.

AI applications can easily be distinguished into three different forms:

[a]. **Image processing**, or vision systems which can serve as eyes for industrial robots or surveillance satellites and perform grueling inspection jobs on the assembly line;

[b]. **Natural Language** programs that can comprehend and obey orders in everyday English;

[c]. **Expert or Knowledge Base** systems capable of bringing specialized knowledge to bear on fuzzy, non-numerical problems that have hitherto resisted solution by computer.

Table 1: Some Existing Expert Systems

System	Area of Expertise
AQ11	Diagnosis of plant diseases
CASNET	Medical Consulting
DENDRAL	Hypothesizing molecular structures from mass spectrograms
Dipmeter Advisor	Oil Exploration
EL	Analyzing Electrical Circuits
INTERNIST	Medical Consulting
KMS	Medical Consulting
MACSYMA	Mathematical formula manipulation
MDX	Medical Consulting
Molgen	Planning DNA experiments
MYCIN	Medical Consulting
Prospector	Mineral Exploration
Puff	Medical Consulting
R1	Computer Configuration

"Expert systems have been developed for a number of different problem areas, including diagnosing diseases and suggesting treatments to doctors." Courtesy of Zamir Iqbal.

The goals of computer vision are diverse but may be characterized by seeking answers to "What", "Where", and "Why" questions. The "What" question concerns the identification of objects in a scene. "Where" questions involve the perception of the environment in time and space; and "Why" questions address cause-and-effect-type relationships between objects.

Vision systems promise to make production machinery (Robots) more "intelligent", that is, to make them more adaptable, flexible and autonomous. However, to make robots more responsive to their environment, they must first be able to perceive it. Right now the emphasis is on equipping them with this vision capability. AI enables robots to recognize a variety of silhouettes from simple features such as area and perimeters of shapes, holes, or the ratio between their largest and shortest dimensions. Once an object is recognized, the computer can direct a robot's hand to grasp it at the proper point.

A valuable contribution of AI may be to help stem the loss of one of society's most priceless assets: expert knowledge. This branch of AI, referred to as **Expert Systems**, is able to make decisions on a par with human experts, primarily because its structures reflect the manner in which a human

specialist might arrange and make inferences from his knowledge of the subject.

UNLIKE most conventional programs which consider a small number of clearly known alternatives and assume that the end product will be a firm, usually numerical, answer, knowledge base expert systems are particularly well suited for circumstances in which alternatives are many; theories uncertain, data incomplete, and conclusions likely to be expressed as unquantifiable likelihoods. Most of the time, these are the very circumstances in which most humans make their really important decisions.

Diagnosing diseases and suggesting treatments to doctors was among the first applications that occurred to AI researchers. An influential example is the program MYCIN, which takes a small number of known symptoms and, as an expert physician might, advances tentative hypotheses, or hunches, as to what the disease is. At every step, MYCIN explains its line of reasoning, printing out the rules it is following and the relative certainty of its conclusion and even citing the relevant medical literature!

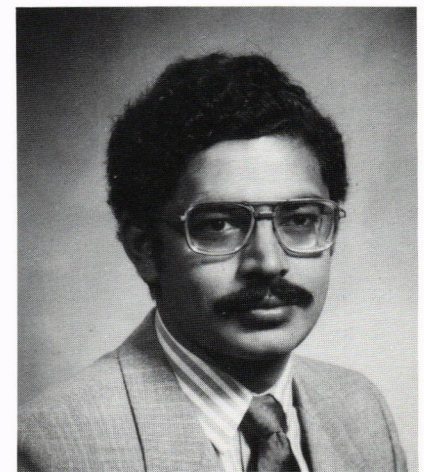
Experts systems have been developed for a number of different

problem areas, and Table 1 lists only a few of these systems. In addition, several computer systems and languages are being developed to provide tools for creating Expert systems, including AGE, ARS, EMYCIN, EXPERT, KMS, OPS.

WHAT LIES AHEAD: COOPERATION OR OPPOSITION?

Any field must have criteria for determining if work done in it has been successful. In some fields, the criteria are firmly established. Criteria for success in AI are not so firmly established because the field is still young, it is extremely broad, and much of it does not seem susceptible to conventional mathematical treatment.

Most AI researchers are convinced that advances in AI will come steadily now that the research effort is proving itself. They believe that AI will provide a quantum leap in human productivity, long before computers like 2001's HAL, become commonplace. And they assert that such thinking machines are not very far in the future. They believe that by the year 2001, computers based on AI will be cooperating with humanity, instead of opposing it, in its quest for progress.



COURTESY, ZAMIR IQBAL

Zamir Iqbal is a Graduate Student, studying Computer Science. He is the current President of the Engineers' Council. Zamir received his Bachelor's degree, with Special Honors, from GW, and maintains a special interest in the field of Artificial Intelligence.

by **Stephen A. Osella**

"IN THE last ten years, the engineering profession has seen Computer-Aided Design/Drafting systems make the trusty draftsman an almost obsolete entity. Now, the impending merger of this field with the field of Expert Systems or Artificial Intelligence threatens to send the engineer packing, as well. This will not happen overnight, as these fields are still

The idea of Computer-Aided Design (CAD) has been around since the late 1960s, when computer hardware and software technology progressed to a useful level. The term is used both in Electrical Engineering and in Mechanical/Civil Engineering design. Actually, many concepts are shared between the two disciplines even though the computer might be used in different ways for each.

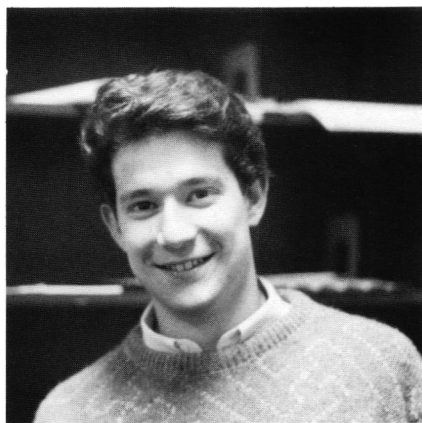
Today, Computer-Aided Design in Mechanical/Civil Engineering takes many forms: Numerical Analysis, Finite Difference Analysis, Finite Element Analysis, Surface/Solid Modelling,

in computer systems and inferences drawn from that knowledge. Therefore, throughout the 1970's, a main theme of artificial intelligence research became the study of knowledge-based systems or what came to be known as **Expert Systems**.

Modern Expert Systems are characterized by three fundamental elements: the **Knowledge Interpreter**, the **Knowledge Base**, and the **Working Model**. The Knowledge Interpreter uses the information contained in the Knowledge Base to interpret the current contextual data in the working Model. In addition to

Expert Systems Point to Possibility of Automated Design

practically in their infancy. The merging of the two sciences is still much in the research phase, but their union would represent a radical step forward in engineering design.



KWANG-YONG QUEK

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Computer-Aided Drafting, Computer-Aided Manufacturing, Dynamic Analysis, Kinematic Analysis, and Optimization. In Electrical Engineering it is basically used in design and fault diagnosis of digital systems. Some form of Expert System could be used in conjunction with many of the above areas.

"THE development of Expert Systems has its roots in Artificial Intelligence research. In fact, Expert Systems are often regarded as representing a subclass of artificial intelligence. Initially, AI researchers attempted to create a General Problem Solver (GPS) that would be able to perform any sort of decision making. However, due to the nature of exhaustive searches of the problem domain, it was found that the problem would progress down "endless paths", where no solution was possible.

It was later realized that computers should instead solve well-defined problems. This conclusion led to the study of how knowledge could be represented

operating on the Knowledge Base, the Knowledge Interpreter also has the responsibility of acquiring new knowledge, updating the current knowledge and explaining system features or details of operations such as inference-making.

Researchers are not yet quite sure to what extent Expert Systems can be used in Computer-Aided Design. Present day Expert Systems exist only as stand-alone products; however, their true potential lies in being incorporated in CAD packages where they will be able to monitor the design process from start to finish.

The research on how computers can aid the design process has all but just begun. It will be at least five years before most CAD packages become complete and most engineers feel comfortable with the idea. Likewise, the study of Expert Systems has a long road to travel before they become useful to engineers. It should be a while yet before robots and computers displace human engineers as designers of mankind's new technology. ■

GET RID OF YOUR LPs AND FLOPPIES: THE COMPACT DISC REVOLUTION IS HERE

by Daniel L. Briller

"SUPPOSE I came up to you today and told you you could throw away your entire record collection and not miss it? Suppose, also, I told you that that box of floppy diskettes you just bought for your computer would be next to useless in a year or two. The scenario I'm outlining is actually not far from the truth. It is not invoking fantasy by saying that the vinyl record and floppy diskette industries are being mortally threatened—by a shiny silver little platter called the **compact disc**.

SCINTILLATING SOUNDS STUN RECORD INDUSTRY

Walk into any record store in downtown New York, L.A., or Washington on an average Saturday afternoon, and you're sure to see hordes of eager shoppers snatching up compact discs. Above and beyond the fad phenomenon that is accompanying them, what is their attraction? It's very simple: as recording media go, they are almost completely noiseless.

"Compact discs take care of the noise problem by eliminating all mechanical action from the playback process."



"A compact disc is a metal-coated platter, 4.7 inches in diameter, with a doughnut-like hole in the middle." Courtesy of Scientific American.

Noise is the music lover's sworn enemy, the one thing that can spoil a great recording. On phonograph turntables, it often takes the form of "wow" or "flutter"—distortions in pitch which arise from improper balance of the turntable or misalignment of the stylus arm. On cassette tape players, it is often heard as hissing or clicking, which is caused by dirt or magnetic particles collecting on the heads that unreel the tape. Either of these repetitive noises can make you sick of your favorite recording in a hurry!

Compact discs take care of the noise problem by eliminating all mechanical action from the playback process. When records are played over and over, during a period of several years, the force of the needle digging into the vinyl grooves tends to wear them down. Likewise, the magnetic particles on a cassette tape rub off onto the player heads, clogging them and creating distortion. Compact discs, however, are played back via laser, resulting in sparkling, virtually noise-free sound.

A COMPACT DISC is a metal-coated platter, 4.7 inches in diameter, with a doughnut-like hole in the middle. Information, let's say a recording of Beethoven's Fifth Symphony, is contained in more than eight billion microscopic **pits**, lined up in a 2.5 mile-long spiral track around the disc. The term 'pits' is not really precisely accurate; they are more like raised 'bumps.' The regions of space in between pits are referred to as **lands**.

Musical qualities such as pitch, rhythm, and timbre are stored on the disc in digital form; that is, as a long string of ones and zeros.

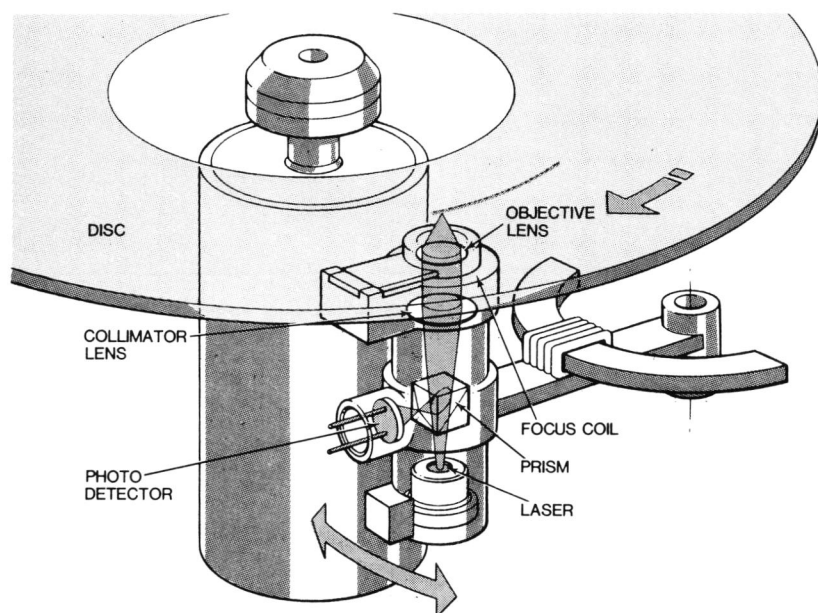
original sound wave onto the recording medium, for example, a vinyl record or cassette. This wave is continuous, and might look like a signal you'd see on an ordinary oscilloscope. Digital data, however, is discrete, meaning each point is either a one or a zero—period. You can think of it in this way: at each point in time, the amplitude of an analog signal has a certain numerical value, say 5 volts at point 1, 2 volts at point 2, etc. This signal can be converted to digital form by **sampling**; that is, by taking values at a set interval of time and then switching these numbers to binary (base two) form. Later, when the recording is played back, the signal must be

detector. They are then decoded (converted back to analog), ready to go to your speakers.

The biggest advantage of compact discs over records and tapes is, as we said, the almost complete absence of background noise. Surface noise, wow, and flutter are non-existent, distortion is extremely low, and frequency response is generally flat. CDs, as they are called, have an incredible dynamic range of more than 90 decibels (the range of a typical LP is less than 65 decibels.) This means that recording engineers can shove all noise down to the lowest end of the audio spectrum, where it is virtually inaudible. The slight whirring heard from the disc spinning is more than counter-balanced by the extraordinary purity of sound heard from the speakers.

CDs offer another advantage over LPs: they correct their own mistakes. If your favorite record is scratched, it's pretty much hopeless. CDs, though, store **error codes** or **error correctors**, along with their music. If some of the data bits on the disc are inadvertently destroyed, the error codes can 'fill in' the missing information. As many as 3,000 bits could be destroyed, but, thanks to error codes, you'd never hear the difference.

How CD players work



Unlike conventional LPs, compact discs are played "inside out." The laser starts at the middle of the disc and moves toward the edge, passing over the spinning disc at constant linear velocity. Courtesy of Popular Science.

Transitions from pits to lands are read as ones, while the in-between regions, both on pits and in lands, are read as a string of zeros. What makes two pieces of music, or two different recordings of the same piece, different is variations in length of the pits and in spacing between them.

The whole idea of digital sound is also very new, and a departure from the recording technique used since the time of Edison. Ordinary analog recording involves placing a physical representation of the

reconverted to analog form, in order for it to pass through an amplifier.

As mentioned earlier, playback of a compact disc is entirely unmechanical. Instead of a needle tracing the grooves of a record, a laser beam **scans** or passes over the surface of the spinning disc. This surface, which is highly reflective, is a continual series of pits and lands. As the beam strikes these areas, it scatters into a rapidly blinking series of on-off pulses, which are picked up by a special

COMPACT Discs have progressed from being a toy of the wealthy and the curious to something one of your friends or neighbors is likely to have in his or her living room. Prices have fallen dramatically in the last few years: from \$1,000 for a CD player and \$20 for a disc, in 1983, to less than \$200 for a player and \$12 for a disc, in July of 1985. As affordability has improved, so have sales: from 35,000 in 1983 to 240,000 in '84, to a projected 600,000 in '85. In the words of one Cincinnati record store owner: 'We can't order them fast[sic] enough.'

CDs have already begun to move beyond the confines of the living room, too. Walkman and car stereo models have been developed and are currently being perfected. These types of players, in addition to being very small, present problems because of the

Medium	Quantity	Cost (\$)
Magnetic disc	80 200-mega-byte packs	40,000
Computer tape	90 tapes (2,400 ft., 6,250 bits/in. 8-track)	1,350
High-density magnetic tape	2,400 ft. (2-in. tape)	100
Optical disc	One 12-in. disc	10

*"Compact discs would offer both greater durability and a vast increase in the amount of memory available." This table illustrates how the same amount of data that would cost \$40,000 to store on magnetic disc can be stored on just **one** optical disc.*
Courtesy of Popular Science.

delicacy of the equipment vis-a-vis its playing environment. For a CD to play properly, the laser beam must stay focused on a point 1.7 microns (.000068 inches) wide. This is indeed a difficult requirement to satisfy for equipment that must travel over potholes or remain strapped to a jogger's belt.

Sony has been working on ways to get around this problem. For one thing, they have reduced the mass of the pickup considerably, the result being less momentum transferred to the player during jolts. They've also introduced a linear motor tracker: a pickup that moves by sliding along rails, instead of by the motion of cumbersome gears.

IS THE FLOPPY DISKETTE DOOMED?

Magnetic floppy diskettes have two overwhelming drawbacks: they are delicate and hence often unreliable, and the amount of information they can store at a time is limited. If adapted for this function, compact discs would offer both greater durability and a vast increase in the amount of memory available per disc. One CD could conceivably hold 540 to 600 Megabytes of raw data. This is equivalent to 1200 floppy diskettes, 500,000 typed pages, or a whole 50 volume encyclopedia!

Indeed, all conventional data storage media are being seriously endangered by the rise of CDs, as shown in Table 1. Notice both the tremendous savings in cost and in physical space occupied by the medium. CDs, often called optical

discs in computer context, are certainly of a size compatible for use with home computers. This means no more banks of floppies or expensive hard disks. If a single optical disc can store the name and address of every man, woman, and child in the United States, think of what it could do for your home software library!

For all its wonderful capabilities, optical disc storage technology is still around the corner. Certain operational characteristics of the disc must still be perfected. Ordinary audio CDs are read-only devices, meaning that information can be extracted from them but not returned or restored. Usually, with computers, you would want read-write capability, else how would you store new programs and data? To do this, optical disc drives must have powerful enough lasers to burn new tracks of pits and lands onto the discs' surfaces. You might also want the discs to be erasable, so that you could get rid of old, unneeded files. This feature requires a complex magnetic-optic interaction, whereby magnetic particles in the disc align themselves in a magnetic field.

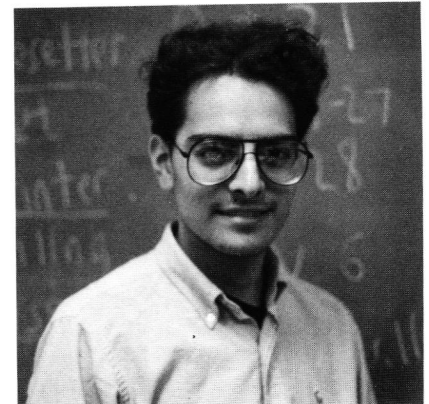
HOLLYWOOD IS JUST THE BEGINNING FOR VIDEO DISCS

I haven't yet touched on the whole area of videodiscs, which, in principle, work just like compact discs. The major difference is that they can store visual, as well as audio, information. Videodisc players (also called Laserdisc players) are currently available to consumers, with accompanying discs

containing anything from old Hollywood films to opera.

Other, non-entertainment applications exist, too. As one example, satellite photographs of the Earth can be digitized and stored in high-resolution form on these discs. Listings of hospital records and library files can be displayed instantly, without the added cost of accessing a central data bank over long distance telephone lines. There are also machines capable of handling interactive video, whose applications range from home electronic football games to computerized information booths. X-rays, photographs, TV images, and electronic mail may all eventually reside on cheap, durable, and efficient videodiscs.

Compact discs have already taken over the audio industry; any trip over to Tower Records will show you that. Their potential computer applications, though, are largely unexplored. It remains to be seen whether the costs in time and labor to overcome the existing problems will justify developing the technology to a marketable stage. At any rate, it seems that the tried-and-true vinyl record will soon disappear altogether, as a victim of progress and a legacy of past achievement.



KWANG-YONG QUEK

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Intelligent Autos Organize Driving at the Touch of a Finger

"ARE YOU tired of rummaging in your glove compartment for maps, fuel logs, etc.? Well, a computerized car may be just what you need. A new, touch-operated computer screen, driven by an 8-kilobyte microprocessor, is now appearing in a U.S. production automobile. The 1986 Buick Riviera maintains over 100 control functions. Just with a mere touch on the programmed-sensitive screen, one may bring up information for climate control, trip calculations, engine diagnostics, radio and tapedeck operations, and instrument displays.

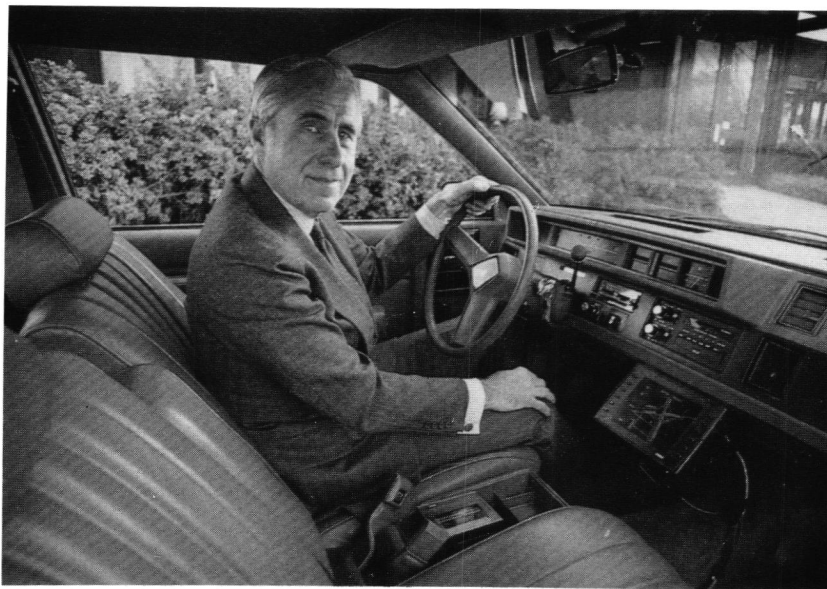
Each special function has its own set of readouts. For example, the fuel consumption and gas mileage are shown on one page of the readout. The amount of fuel consumed and the gas mileage of the automobile are calculated at the driver's touch command, from the moment the ignition is

switched on. Another page of readout has the **trip monitor function**, which estimates the arrival time. This, too, is obtained solely through the driver's touch. He/she enters the distance to a destination, and the system makes calculations on the basis of the car's average speed over the last five to ten miles.

Along with having a wide range of information at your fingertips, the switching system of on and off is also activated by a mere touch of the door handle. The display screen appears as soon as the door is closed. As one would expect from a futuristic car such as this, the power automatically shuts off shortly after the ignition is switched off.

Such highly developed automobiles will revolutionize the automotive industries around the world. Many advantages may result from such cars—one being allotment of storage space. Just think of it, all the cluttered mess you may usually be storing in your glove compartment can now be arranged precisely in a small computer, activated with just the touch of a finger.

—Swati Patel



"A new touch-operated computer screen . . . is appearing in a U.S. production automobile." This screen can navigate, calculate mileage traveled, monitor vital engine functions, and much more. Courtesy of High Technology.

Continued from page 2

ripe items by their color and size. Meanwhile, the unripe fruit may be left for later harvesting.

Other applications are being tested by researches at the University of Florida, Gainesville. These scientists are using Machine Vision to pick ripe citrus fruit. Using a yellow filter over the camera lens, the fruit that is ready to be picked appears white, while young, small green fruit appears dark.

Machine Vision should not be limited to food harvesting. Citrus growers, for instance, may use these systems to grade their fruit according to the color uniformity. Blotches in color lead the producer to transfer these specimens to juice works, instead of to food markets. Such separation of objects requires highly sophisticated computers to compare gray levels against neighboring picture elements, thus assessing color uniformity.

More beneficial applications lay in line for the future of Machine Vision and food-processing. Arthur D. Little, for example, is researching systems that distinguish between the different ingredients in frozen mixed vegetables. It is not required that these machine systems work with full color processing; instead, appropriate color filters can be placed over monochrome cameras. In this way, a color filter is put in front of the camera, and the six vegetables usually found in the mixture are observed through different intensities. For instance, with a yellow filter, the corn will appear very light, while the peas are dark, and the carrots are somewhere in between. The computer may also check that the mixture has every specimen in correct proportion.

With such progress, computer-aided Machine Vision systems will further advance into the agricultural industry, as well on to other fields, such as medicine. Who knows, maybe Machine Vision can someday pick out tumors in the same manner as it does ripe fruit.

—Swati Patel

From Cardpunch to CAD/CAM: Computers Invade the Classroom at GWU

by Jeff Winbourne

"STARTING OUT 27 years ago with a "card puncher" and today teaching programs that put us on the "frontier" of technology, the use of computers in class work is moving in many exciting directions in the School of Engineering and Applied Science (SEAS). While some departments lag behind and some obstacles remain, the trend is toward having some kind of computer project in nearly every class, over the next few years. Some new areas of computer-aided education at GW are: Very Large Scale Integrated Circuits (VLSI), the design of computer chips, the beginning of a computer-aided manufacturing program, and the installation of a special computer classroom. Future plans, one or two years hence, include networking all computers on campus and automating the library.

With the installation of the computing center on the fourth floor of Tompkins Hall, the basis exists to accelerate the development of course-related computer work. The IBM CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) gives the school the opportunity to teach up-to-date techniques for analyzing, understanding, and solving engineering problems, all sorely needed in industry today.

THIRTY YEARS BRING PROGRESS AND GROWTH

In 1957, SEAS received its first computer. It was an old relay computer—"a card puncher." Installed in the basement of Tompkins Hall, it was used solely



KWANG-YONG QUEK

The Digital VAX 11/780 mainframe computer is, according to Michael White, 'considered the premier mainframe computer in academics and graphics-related areas.'

to study computers in the computer science area—in other words, how they worked. Faculty mainly studied it, but did do some limited programming on it. At that time, computer science work as we know it today was called **machine computer**.

In 1960, the old relay machine was discarded, and the school got a tube machine from government surplus. This huge computer was located on the first floor of Tompkins Hall. Again, study with it was focused on how the machine worked—very little programming was performed on it.

Finally, in 1961, the University opened up its first computing center. The first Fortran programming course was introduced in 1965 as a senior-level class.

A major development occurred in 1984 when SEAS opened the computer center in Tompkins Hall. Organized around an IBM CAD/CAM system, the center

serves as the school's general purpose computing resource and is shared by all four departments.

The school got the IBM system as the result of a competition. The award included the 4341 IBM mainframe, and peripheral equipment such as 17 graphic work stations for computer-aided design. Not counted in the \$2 million award was the system software and applications software, which was donated to the school and is continually being updated.

The first class to use the CAD system was a senior design class in the spring of 85 and last semester, fall of 85, as many as four classes were using the CAD/CAM system, in total, about 120 students.

Mike White, the computing center manager, pointed out that as the need arises to expand, "the software is already there. This includes software for computer-aided manufacturing research and robotics research."

The facility, which recently opened a second CAD/CAM room has quite a bit of equipment. It is all housed in several main areas:

1. The microcomputer lab, which centers around the Apple Computer and MacIntoshes—the MacIntoshes, as White also pointed out, “are the latest innovative graphics-oriented computer in the micro area;”
2. The Digital VAX or “the VAX”, which, according to Mr. White, “is considered the premier mainframe computer in academics and graphics-related areas;”
3. The Graphics Lab;
4. A new addition, the AT&T 3B2 computer, donated recently and scheduled to be on-line this semester for computer science students;
5. Graphics and Computer-Aided Design (CAD), which includes the Sun Micro system workstation, with a large color graphics monitor and specialized set of software from the University of California-Berkeley. This equipment, for instance, is used to design computer chips.

A goal for the near future is to tie this equipment together to form a network. Files could then be shipped back and forth from VAX to IBM, and so on.

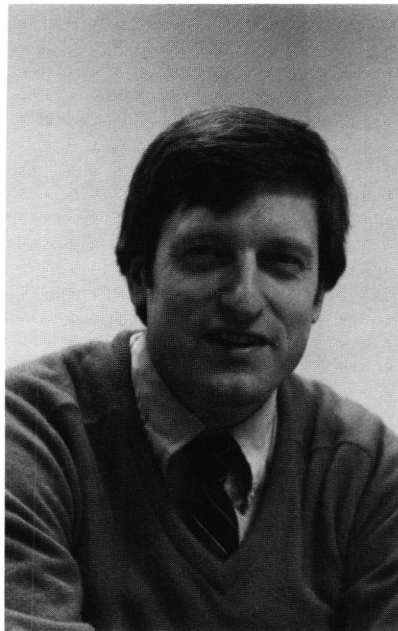
An additional resource available at the Center is the ability to send and receive messages to other schools through a nationwide network. This can be used to request information on software or ask about specific routines that have been developed in any other center.

NEW PROGRAMS INCREASE “COMPUTER COMPETENCE”

One of the “frontier” courses using CAD tools at its center is taught by Professor Mona E. Zaghloul. This course, EE126, involves designing very large scale integrated circuits to be placed on a 2x3 millimeter silicon chip. The students can design the chips for any purpose—calculators, games, or whatever they wish.

The students turn in the circuit design on a deadline, which is coordinated with a silicon foundry

in California. The designs are sent to the foundry via a computer network. The finished chips are then sent back to GW in about 8 weeks. Then, in the follow-up course, EE128, the students test and debug the chips. The class will hold a demonstration, sometime this spring. According to Prof. Zaghloul, “This is new to engineering education nationwide and GW is one of the pioneers in this area.”



KWANG-YONG QUEK

Mr. Michael White is in charge of the new SEAS computing facility.

Another innovative program in its beginning stages has been introduced in computer-aided manufacturing. It is highlighted by the establishment of the Center for Advance Machine Automation (CAMA). This program is headed by a newly hired professor, Dr. Bruce Kramer. It will center on automated machine tool and robotics research, all of which will be interfaced into the IBM CAD/CAM facility. According to Prof. Kramer, “The next technology that will be fully automated and unmanned will be the machining process.” The program will concern studying both the processes involved and the development of software. “The machining/research facility,” Kramer continued, “will be measuring parameters such as force, vibration, and temperature during the machining process, the

overall goal being to achieve maximum productivity.”

Involved in the research will be Professor Nozer Singpurwall, a and others from the Reliability Institute in the Operations Research (OR) department. They will be using Bayesian statistical techniques to update the model—with the goal of evolving some new control systems.

While this program is just getting off the ground, it “has a few irons in the fire.” First, is acquiring equipment which will be the main component of CAMA. This will include a Numerically-Controlled (NC) machining center and an NC lathe, as well as an industrial robot. This equipment will be interfaced with the IBM CAD/CAM system. This is a big plus because, according to Mike White, “All the CAD/CAM packages can link to the manufacturing side and are capable of producing numerical control tapes, some of which have robotics applications.” Also, new courses in computer-aided manufacturing are being added to the course listing. The proposed courses include computer-integrated manufacturing and tribology, as well as the upgrading of existing courses such as ME192, Manufacturing Processes.

LEARNING TO “CHASE ELECTRONS”

The Electrical Engineering/Computer Science Department has a fairly broad assortment of classes which use computer projects as part of the course curriculum. These vary from the study of computer languages, such as Pascal and Fortran to the “nuts and bolts” of how a computer operates, and use of the CAD/CAM system to design circuits.

To teach computer architecture and how to interface the different machines (or as Dr. Arnold C. Meltzer calls it, learning the art of “chasing electrons”), a microcomputer lab, equipped with a DEC PDP 1134 computer, is used. In one course the students use this lab to build terminals and connect them in a local area network.

"ANOTHER important teaching resource Dr. Meltzer pointed to is a software package called SPICE. In the 1970's, prior to the arrival of SPICE, the department used a program called ECAP. SPICE will eventually be used by all circuit analysis courses. It is, as Prof. Zaghloul pointed out, "for an electrical engineer, like learning what a resistor or a capacitor is—it is fundamental." Within a short number of years almost every electrical engineering course will be using some computer program as an applications program to assist them in doing analysis," added Prof. Meltzer.

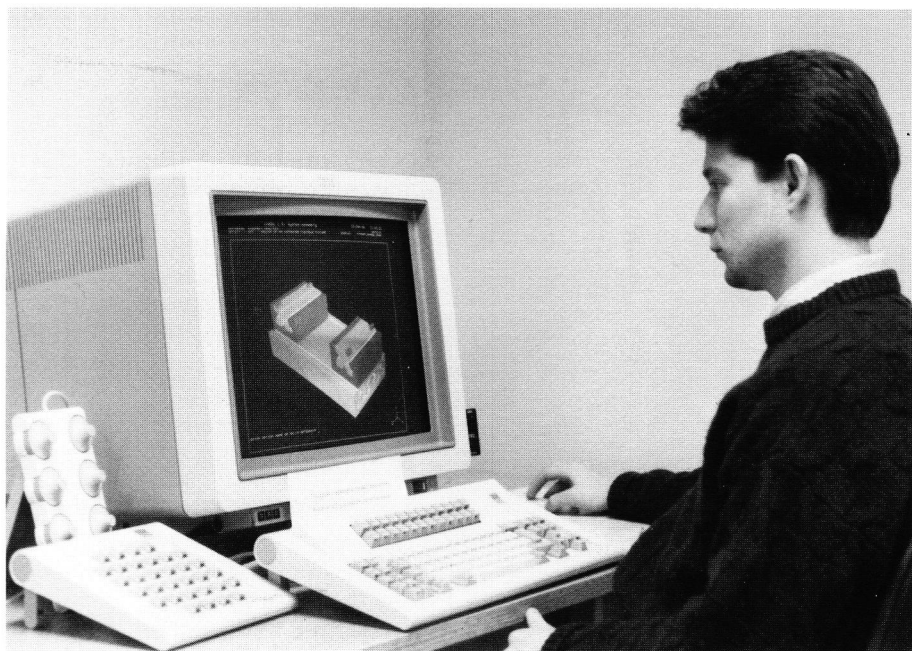
DISKS IN TEXTBOOKS MODERNIZE LEARNING

Class work and computers are becoming synonymous in the Operations Research Department. The use of computers in this department, "introduces a whole new insight into any course. It assists in seeing the dynamics of the problem by changing the parameters—sort of asking 'what if' and getting the solution very quickly," explained Donald Gross, Department Chairman of OR.

OR began using computers for research seven to eight years ago. It taught its first linear programming course, using a "canned" code, about that time. But as Gross pointed out, it was used sporadically; some professors used it, some didn't.

Four or five years ago, new canned codes were introduced, which were much easier to use and to teach. At the same time, more work was introduced into the linear programming course, and, 2-3 years ago, programs became available for general operations research.

Now, the software package students are using comes with the textbook! This is being used for the first time in the second semester OR survey course. This practice, according to Dr. Gross is becoming commonplace in new OR textbooks. While students in this department still have to do problems by hand, just to learn the basics, they are given much more realistic problems for the



KWANG-YONG QUEK

The recently-installed CAD (Computer-Aided Design) system allows the user to model three-dimensional parts with great ease and precision.

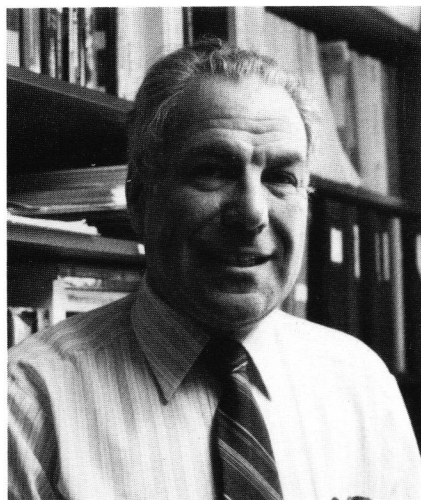
computer. Some of the undergraduate classes compare commercial software packages related to specific problems distributed by different companies. In other cases, faculty and students write their own software. As an example, Gross pointed to a forecasting class, taught by Dr. Singpurwalla, where each succeeding class works on improving the software code written originally by the previous class.

One of the important developments in computer-aided education in the OR department has been the establishment of the Decision Support Center (DSC). This center is operated jointly with the Engineering Administration Department (EAD) and is located in Staughton Hall. This center, which can also serve as a classroom, has about a dozen microcomputers, on which research can be carried out. In addition, Prof. Gross added: "The classroom has a full screen projector working off the computer. So if the instructor wants to do something and have the class watch, the class can watch it on the screen. The facility has been very useful to us. In both EAD and OR, our lab is really the computer."

MAKING MACHINES MIMIC OUR THOUGHTS

The Engineering Administration Department makes very extensive use of computers in course work, although the approach to using them in class work is quite varied within the department, itself, and from other departments within SEAS. For instance as the Artificial Intelligence (AI) Program Director, Dr. Barry Silverman explained: "The approach of AI to computing is not from the point of view of a computer scientist, i.e. from the point of view of 'study my data structures and the internal workings of my computer.' Rather, we look at what are the cognitive capabilities that you can put into a machine. What is management, intuition, judgement, and how can machines mimic them?" Or, as Dr. James F. Dinwiddie pointed out, "we are trying to fill a gap in industry between those who speak 'computerease' and managers who can't communicate with them."

The AI program has developed a program to meet this twofold problem. Courses that include mostly middle level executives as students, according to Silverman, "many of them are afraid of PC's, don't trust them. They have had



KWANG-YONG QUEK

Professor Arnold Meltzer is a twenty-six year veteran of the EE/CS Department.

all the bad experiences." Courses are designed to make use of the DSC lab and the class works on developing small-scale "expert systems" to remedy those feelings. The work in the DSC lab is aimed to get the computers to "think" as a result of the expert systems students write, helping them solve management problems relevant to their needs. All the while, these expert systems attempt to mimic human thought processes.

The AI Department accumulated about \$500,000 worth of software for its program in the DSC. The department is also involved in research projects, such as cognitive modeling, computer-aided manufacturing, expert systems, and automatic programming.

In the information management program of EAD, Dr. Dinwiddie, set up the use of computers some five years ago. This was part of a cooperative effort with the EE/CS department, and is run parallel to AI. According to Dinwiddie, the concept here is to use computers as a tool in the management of information, focusing on application. "[We want] to develop a second path, software engineering being one path, and the other the applications path. This is to focus on getting the computer to do what you want it to do on the one hand, and, on the other, deciding 'what do I want the computer to do?'"

Professor E. Lile Murphee, Jr., a

recent addition to the EAD staff, has started a course sequence using computers in the construction management program. In speaking of the goals of his program, Murphee stated, "Every graduate student in our program should be on the computer every day." Since the use of computers is so widespread among construction companies, it is vital that the students be familiar with computers especially micros, and their software.

Prof. Murphee is introducing the use of a software package called "Reflex." This is a very flexible data base management system. It can draw billing or sales forms on the screen, to be filled out by the operator. It also has the capability to do statistical analysis.

FIRST using computers in classwork ten years ago, the Civil, Mechanical, and Environmental Engineering Department (CMEE) now offers programs including a masters degree in computer-aided design. This started when Professor Theodore G. Toridis introduced computers into his structural analysis classes. According to Prof. Douglas Jones, "the effort was made to incorporate the available concepts of CAD existing at that time, which were pretty primitive. There was nothing like the interactive graphics we now have. It was sort of like, 'here's how you draw a line on the graphics terminal. They also did things like numerical analysis and finite element analysis. This was the core of the original program we offered, plus some computer science.'"

Things really began to change about three or four years ago when the American Board for Engineering Training, the accreditation board for engineering schools, wanted more computer education in mechanical engineering. Prior to this the department offered three options or electives you could take and one was "computer-oriented mechanical engineering" Only about five or ten students chose this options.

Prof. Jones went on to add that about two years ago, computer

usage was introduced into the "classical mechanical engineering courses." This included the start of a junior level numerical analysis course, following with additional computer projects in vibration analysis and thermodynamics. Also, at this time, a course in methods of mechanical engineering experimentation was changed to be a computer-based course.

More recently, a design sequence has been introduced using the CAD system. This runs for three semesters beginning in the junior year. There are plans to gradually expand the CAD/CAM system throughout the four-year sequence, starting with Engineering Science 4, an introductory graphics course for freshmen. This will enable the freshmen to start using the CAD system very early in their undergraduate program. Dr. Jones also pointed to the new computer-aided manufacturing programs as another major area of expansion in the department.

In the Civil Engineering (CE) Department, computers are used mainly in the structural analysis courses, which account for almost 20 percent of the courses CE offered this spring semester. Professor Toridis explained, "In structural analysis, the computations can be very tedious if done by hand, so we rely on the computer to analyze the larger systems such as bridges." Toridis went on to say, "using computers to do structural analysis is especially helpful since the student and the instructor is able to ask 'what if'-type questions." "In the structural areas of civil engineering at GWU," Toridis stressed, "there is no need to expand the use of computers. In any particular course where the use of computers is significant, we have already introduced them. But we are constantly trying to keep up with recent trends."

ISSUES AND RESOURCES: WHO PAYS THE BILLS?

When it comes to the question of which way to go in improving and expanding computer related class work in SEAS the decision is

focused on a few issues. These are resources, computer fees, and time.

The resource problem is two-sided. The overriding issue concerns resources for professors: resources to continue developing or to start developing new computer-related classroom projects. Focusing around whether to give each professor a PC for his or her office will advance or start some toward this goal. At this time, SEAS is budgeting \$5,000 for each professor to buy whatever computer equipment they want for their office.

'SEAS is budgeting \$5,000 for each professor to buy whatever computer equipment he/she wants for the office.'

Will this approach work? Opinions vary. Most of the professors seem to be in favor of this proposal. This move, in their opinion, would encourage more involvement by each professor in using the computer in their office and have subsequent positive effects in the classroom. As Dr. Douglas Jones pointed out, "It is an important step. We do have some faculty that, because of the type of course they are teaching, haven't felt the need to get heavily involved with computers. This will be valuable in involving them more in using computers." Dr. Donald Gross stated that he felt, "having a PC in their office would help with computing work in schools but also in administration work."

Another opinion expressed by Professor Meltzer, however, was that he was "not sure if it will increase computer usage. If a guy wants to use a computer, he will, whether he has a PC in his office or not. There are plenty of computers just across the

hall. Having one on his desk doesn't mean he will use it." Nevertheless, he also added that, "It would probably make things easier for the faculty."

THE OTHER side of the resources issue is availability of machines, especially microcomputers. In general, it seems there are adequate facilities for SEAS students, and those that exist are being expanded or plans to do so exist. But some areas there are shortages or need to update existing equipment. Dr. Murphee pointed to this problem with existing equipment. Murphee said, "There are not enough small microcomputer-type machines—that is one deficiency." He also pointed to the need to upgrade the equipment he uses in classes—to make the hardware more compatible for the software. In speaking on accessibility of computer resources, Professor Meltzer explained, "We are one of the few universities, believe it or not, where you can go in and use all the computers you want. At very low cost. We aren't forcing students to buy a PC and pay for it over the years, as some schools are doing."

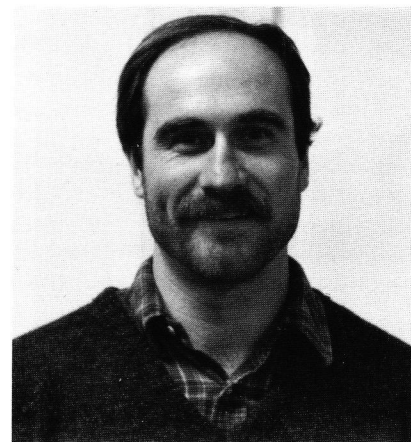
The computer fee, which is designated to buy new equipment, drew mostly negative responses. Among the professors interviewed, the \$50 computer fee was seen as a source of resistance by faculty to developing more computer-related class work, especially when it only involves one or two homework assignments. Reflecting this, Dr. Meltzer stated, "If the administration really wants to encourage the use of computers throughout the university, then they have to do away with it (the fee)." Dr. Gross pointed out that "The fee should be paid by another means and (the use of computers) treated like getting a book out of the library."

Mike White, Computer Center Manager, made the point, "We have probably wasted more time talking about the fee than it really merits when you look at the amount of money paid in tuition,

\$100 is a bunch of hand-wringing over a rounding error'" On the positive side White went on to say, "The money coming in from that \$100 is suppose to be earmarked for new equipment. Looking at it that way, the computer facilities will improve, the reputation of the school will improve and the value of the person's education improves."

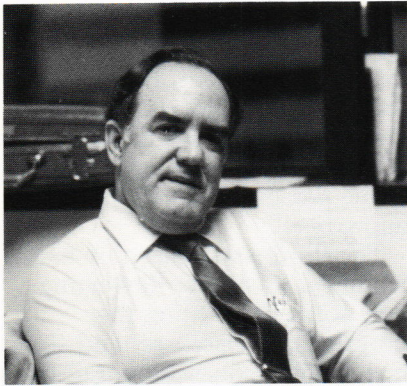
The third issue raised by faculty members was time. Reviewing new software, writing the programs for class use, and so on is quite time consuming. OR has a graduate student assigned to help faculty work with new software, in order to expedite the process. On the other hand, having a personal computer on one's desk was seen by some as a time saver. "For looking up student files, all the paperwork on my desk should be on the computer—not on my desk," said Dr. Dinwiddie.

In the course of resolving some or all of these issues and with the introduction of new programs, computer-aided education at GWU-SEAS is attempting to meet the needs of students now and in the future. It should help prepare them for the work-a-day world, where computers are becoming increasingly prevalent.



KWANG-YONG QUEK

Jeff Winbourne is a Junior, majoring in Mechanical Engineering. He is Campus News Editor of *MECHELECIV*, a job requiring a lot of legwork! Jeff's special interests lie in the field of Computer-Aided Manufacturing (CAM).



KWANG-YONG QUEK

Dr. Oscar Garcia is trying to get computers to read and understand text material.

Can a Computer Read and Understand Text?

"DR. Oscar Garcia wants to find out. Professor Garcia recently arrived at GWU from the University of South Florida, where he was chairman of the EE/CS (Electrical Engineering and Computer Science) Department. He did his undergraduate and graduate work at North Carolina State University and received his Ph.D. from the University of Maryland.

Prior to coming to GW, Prof. Garcia taught for a combined 15 years at the University of South Florida and at Old Dominion University. In between, he also worked for IBM. Prof. Garcia is the former national President of IEEE (as which he served for two and a half years), and he just finished his second term as a member of the IEEE Board of Directors.

His research focuses on Artificial Intelligence. He is trying to get computers to read and understand text material. He is also working on interfacing expert systems and testing them to see if their confidence level can be improved. He is currently teaching CSci 224, Artificial Intelligence, as part of the GWU television course series.

Prof. Garcia is married, the father of two daughters, and enjoys playing raquetball. So far, he is very pleased to be at GWU.

—Il H. Kim

Enthusiastic Part-Timer Shifts to Full-Time

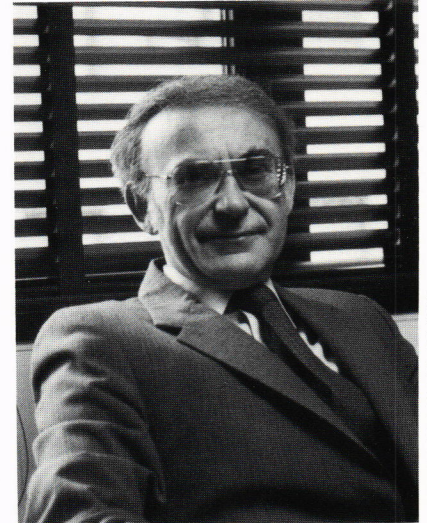
After 15 years of teaching part-time at GWU, Professor Wasylikiwskyj has taken the plunge and become a full-time faculty member. His teaching experience is complimented by his experience in the field. He has worked for ITT, IDA (Institute of Defense Analysis), and Physical Dynamics, where he served as Vice-President.

He specializes in electromagnetic wave propagation and radar signal processing. In addition, he also conducts research in optics. By the way, he is now looking for some graduate students to help him with these projects.

This semester, Prof. Wasylikiwskyj is teaching EE 208, Stochastic Processes in Electrical Engineering and EE 207, Electromagnetic Theory and Applications II. He studied at City College of New York (CCNY) and received his Ph.D. from the Polytechnic Institute of Brooklyn (now Polytechnic Institute of New York.) He is a member of IEEE, Sigma Xi, and URSI.

Prof. Wasylikiwskyj is married and the father of three children. In his spare time, he likes to go mountain hiking and trout fishing.

—Il H. Kim



KWANG-YONG QUEK

Professor Wasylikiwskyj is looking for research assistants in the fields of electromagnetic wave propagation, radar signal processing, and optics.

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